

Supply Chain Strategy of Charge for Technological Connection to Electricity Networks in Electric Industry

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Abstract-Improving the quality of service and the availability of electrical networks for consumers stimulates an increase in the pace of economic development and implies reduction in the cost of technological connection of power-consuming devices to electrical networks by supply chain management. In Russia, approaches to the cost accounting for technological connection to electrical networks and calculation of charge for technological connection, which made a significant amount for consumers until recently, are constantly changing. Despite the varied practice of organizing and paying for technological connection to the electrical network abroad, there is no unified approach to cost accounting and arrangement of work on technological connection to electrical network in the world. In Russia, at present, a methodology has been adopted for unification of standardized tariff rates for work on technological connection for all territorial grid organizations of constituent entities of the Russian Federation. A significant amount of the costs of technological connection to the electrical networks of energy consuming installations of the population, medium and small businesses has been transferred to a single-rate or to the rate for maintaining a two-rate (three-rate) tariff for electricity transmission services. As a result, the charge for technological connection of certain categories of consumers has significantly decreased and Russia's world rating has increased in terms of the indicator "Connection to electrical supply networks", but the tariffs for electricity transmission services for existing "old" consumers have increased. In the context of artificial restraining of tariffs for electricity transmission by the Russian state, the losses of grid organizations have increased and the question remains about the ownership of property built at the expense of consumers for technological connection to consumers' power grids. The authors analyze the indicators of PJSC ROSSETI for technological connection to electrical networks, and justify a tendency on reduction in the costs of power supply network organizations for technological connection to electric grids with an increase in the

number of contracts concluded with consumers. They also propose to cancel the charge for technological connection of power-consuming devices of certain categories of consumers, and also to introduce compensation for costs of the remaining categories of consumers.

Keywords- *availability of power supply, technological connection, state regulation, charge, electrical distribution system, supply chain management.*

1. Introduction

One of the factors for the sustainable development of the economy is reliable, high-quality and affordable electricity supply to consumers. It is the availability of electricity that eliminates the economic inequality of countries and regions; it provides a growing contribution of electrification to the overall socio-economic development of any country and the entire world community, as well as improving the standard of living and health of the population. Undoubtedly, such a mission increases the social responsibility of energy companies and especially the electric grid infrastructure for the implementation of the sustainable economic development principles in various countries. However, to provide and receive electricity services, each producer and consumer must first be connected to the electrical network. Today in Russia, producers and consumers (hereinafter, applicants) must pay a fee for the service of technological connection to the electrical network, and the fees for consumers and producers differ, both in size and in calculation methods. However, this service is not always and not everywhere in the world paid and allocated in a separate fee (tariff). Until 1995, this service was rendered in Russia for an additional independent fee, from 1995 to 2004 the cost of this service was paid at the expense of the tariff for electricity transmission services and was not allocated as an independent fee, and since

2004 the charge for technological connection to the electrical network has been allocated again [1]

In 2012, according to the international ranking of Doing Business conducted by the World Bank to assess the availability of electrical infrastructure by 10 key indicators, Russia ranked 183, including the largest payment for technological connection to the electrical network - 1852% of GDP per capita, and connection time - 181 days [2].

In order to change the situation with performing technological connections in Russia, a roadmap "Increasing access to energy infrastructure" was developed. It has been adopted by the decree of the Government of the Russian Federation dated June 30, 2012 No. 1144-p [3]. The roadmap was designed for 2 years and was essentially completed on time: 15 out of 18 items were fully implemented, one item that concerned the introduction of enlarged price standards for typical technological solutions for capital construction of power grid facilities was at the implementation stage, and two items which were related to encouraging consumers to make optimal use of power grid capacities and the attraction of private investments in the electric grid business have not been fulfilled (and they have not been fulfilled until now). Regarding the implementation of the privatization procedure by subsidiaries of PJSC ROSSETI, it has been decided that the procedure was premature due to a significant decline in market value (in 2013-2014) and the absence of favorable prerequisites, as well as it was later on.

However, the measures taken have contributed to raising Russia's rating up to 141. [4]

2. Materials and methods

By the order of the Government of the Russian Federation No. 1399-p dated July 18, 2015, changes were made to the schedule for issuing regulatory legal acts on performing technological connections to the electrical networks and the work continued.

In 2015-2017, the following activities were carried out:

- the period for preparing and issuing contracts for technological connection (for consumers with a capacity of up to 150 kW) was shortened by 30 days, by allowing parallel concluding of contracts on technological connection with electric grid companies and on electricity supply with guaranteed supply companies;
- since October 1, 2015, up to 50% of the construction cost for electric grid facilities ("the

last mile") are excluded from the composition of the charge for technological connection of power receiving devices with a maximum power of not more than 150 kW. Since October 1, 2017, such costs are completely excluded from the charge and are included in the single-rate tariff or rate reflecting the specific value of expenses for the maintenance of electrical networks of a two-rate (three-rate) tariff for electric power transmission services, despite the declaration of the principle on separate financial accounting by type of activity "Basics of pricing in the field of regulated prices (tariffs) in the electric power industry" approved by the Decree of the Government of the Russian Federation dated 12/29/2011 N 1178 (as amended on 06/30/2018) [5]. In addition, the tax on profits, loss of income received at a technological connection to the electric network and investments related to the development of the existing electric network, including relations between the facilities of territorial grid organizations and facilities of the unified national (All-Russian) electric grid (UNEG), for the purpose of connection new and (or) increase in the capacity of previously connected consumers, are also not included in the payment for technological connection and are included in the composition of the one-rate tariff or the rate for power supply network of a two- rate (three- rate) tariff for electric power transmission services. An exception is investments in the development of the existing electrical network in the case of technological connection of generating facilities to the electric grid facilities of the UNEG. These and other measures taken have led to a reduction in the cost of technological connection for all consumer groups, with the exception of consumers with a stated capacity of 150 to 670 kW. [6]

Positive dynamics only in terms of the cost of connectivity used in the rating failed to ensure Russia to maintain its position, and in 2015 Russia took the 143rd place in the aggregate rating, while the United States occupied 61st place, and Great Britain occupied the 70th one [7, 8, 9]. In order to achieve transparency in the formation of a charge for technological connection and to ensure a greater degree of access to electricity, the FAS (Federal Antimonopoly Service) of Russia has adopted with the order dated August 29, 2017 N 1135/17 a new method for calculating a charge for technological connection, which implies the establishment of standardized tariff rates for all territorial grid organizations of a constituent entity of the Russian

Federation for implementation of the technological connection procedure. [10]. In accordance with the new methodology, the charge for technological connection to electric networks is calculated in 3 cases:

- Upon connection of applicants' newly commissioned facilities;
- When increasing the maximum power of devices which have been previously connected to the network by applicants;
- When changing the power supply reliability category, connection points or the external power supply scheme by applicants, what does not involves revision of the maximum power.

A charge for a technological connection is applied once. Approaches to the formation of the charge for technological connection to the main and distribution networks in Russia are different, as well as in many countries of the world. [11]

In the case of technological connection to transmission networks, the amount of the charge is set by the FAS of Russia, either individually for a specific consumer, if the grid organization (JSC FGC) should carry out activities for the construction of electrical grid facilities from the existing network to consumer devices, or according to the cost-accounting formula on the implementation of measures at standardized tariff rates. In the case of technological connection to the territorial distribution networks, the fee is set by the executive authorities of the constituent entities of the Russian Federation in the field of state regulation of tariffs with the following options:

- In the form of a fixed value, but not more than 550 rubles, in the case of simultaneous fulfillment of the following conditions:
- The maximum consumer power does not exceed 15 kW inclusively, the consumer facility belongs to the third reliability category (by one power supply source), the distance between the borders of the consumer's site and the electric grid facilities should not exceed 300 meters in cities and urban-type settlements or 500 meters in rural areas, to consumers up to 20 kV voltage level of network facilities is required;
- According to the formula that takes into account unified standardized tariff rates or rates per unit of maximum power for all territorial grid organizations of a constituent entity of the Russian Federation, when calculating the charge for technological connection to the territorial electric networks of power consuming devices with a

maximum power of less than 8,900 kW and below 35 kV;

- According to the formula that takes into account unified standardized tariff rates, when calculating charges for technological connection to the territorial electric networks of a constituent entity of the Russian Federation of power receiving devices of individual consumers with a maximum power of at least 8,900 kW and at a voltage level not lower than 35 kV, charges are calculated for technological connection to territorial electric networks facilities on production of electrical energy and for technological connection according to an individual project, in cases of application submitted by a power grid organization. [10] With regard to applicants being legal entities or individual entrepreneurs, for the purpose of technological connection of power receiving devices with a maximum power of over 15 and up to 150 kW inclusively, a contract (at the request of such applicants) in accordance with paragraph 17 of the Rules for technological connection of power receivers of electrical energy consumers, facilities for the production of electrical energy, as well as electric grid facilities owned by grid companies and other persons, provide for electric networks interest-free payments by installments for technological connection in the amount of 95% of the amount of the charge subject to quarterly payment in equal installments of the total installments amount for the period of up to 3 years from the date of signing by the parties of the act of occurrence of grid connection. Expenses for the payment of interest on loan agreements related to the installment payment for technological connection of these categories of applicants are not included in the structure of the charge for technological connection also. [1]. Whereby, the consumer has the right to independently choose the type of charge rate for technological connection provided that the distance from the borders of a consumer's site to an electric grid facility is less than 10 km, the consumer needs a voltage level of up to 20 kV inclusive, and the maximum power of connected power receivers is less than 670 kW. The choice of the charge rate is made by the applicant at the stage of concluding the agreement on the technological connection. [10]

If the consumer has not chosen the type of rate, the network organization has the right to independently choose the rate and calculate the amount of charge for the technological connection. Charges for a maximum power unit and unified standardized

tariff rates for technological connection to electric networks for all territorial organizations of electric networks of a constituent entity of the Russian Federation are broken down by consumer categories, by voltage levels and (or) maximum power volume. Simultaneously with the simplification and unification of charge calculations, the work was carried out to reduce the time of technological connection. Undoubtedly, the introduction of charge calculations according to the new methodology contributed to a further increase in Russia's rating to 10th place of 189 countries in terms of "Connection to power supply networks", as Russian Prime-Minister, D. Medvedev noted on September 4, 2018 at the meeting "On the

operation of the power grid complex" held in the Moscow region. Only in 2017, the cost of technological connection to the electrical network was reduced to 41.5% of gross domestic product per capita, and the time of connection reduced from 160 days in 2016 to 83 days in 2017 [12]

3. Research results

The reporting data for PJSC ROSSETI, which was established in 2013 on the basis of IDGC Holding (Interregional Distribution Grid Company), and unites now about 70% of the distribution networks of Russia and 90% of the trunk networks are presented in the table below.

Table 1. Performance indicators for technological connection activities (technological connections)

Years	Number of applications for technological connection		Concluded contracts for technological connection		Number of executed contracts for technological connection	
	thousand offs	MW	thousand offs	MW	thousand offs	MW
2009	200	16345			108	3261
2010	278	20144	228	7624	134	4198
2011	332	21274	273	8737	168	4576
2012	415	27457	334	11875	210	6098
2013	478	45713	383	26302	262	11219
2014	488	44716	383	17771	346	12702
2015	479	42802	369	14764	393	13377
2016	476	41281	365	15619	384	12751
2017	475	37106	363	14892	374	15201

Source: compiled by the authors on the basis of the information portal of PJSC ROSSETI [13]

The data in the table clearly indicate that over the period from 2009 (after the reorganization of the electric grid complex) to 2017, there was a significant, almost 3 times increase in the number of executed

contracts and the amount of connected capacity, 3.5 times and 4.6 times respectively. The cost of technological connection has significantly decreased during this period. (See Fig.)

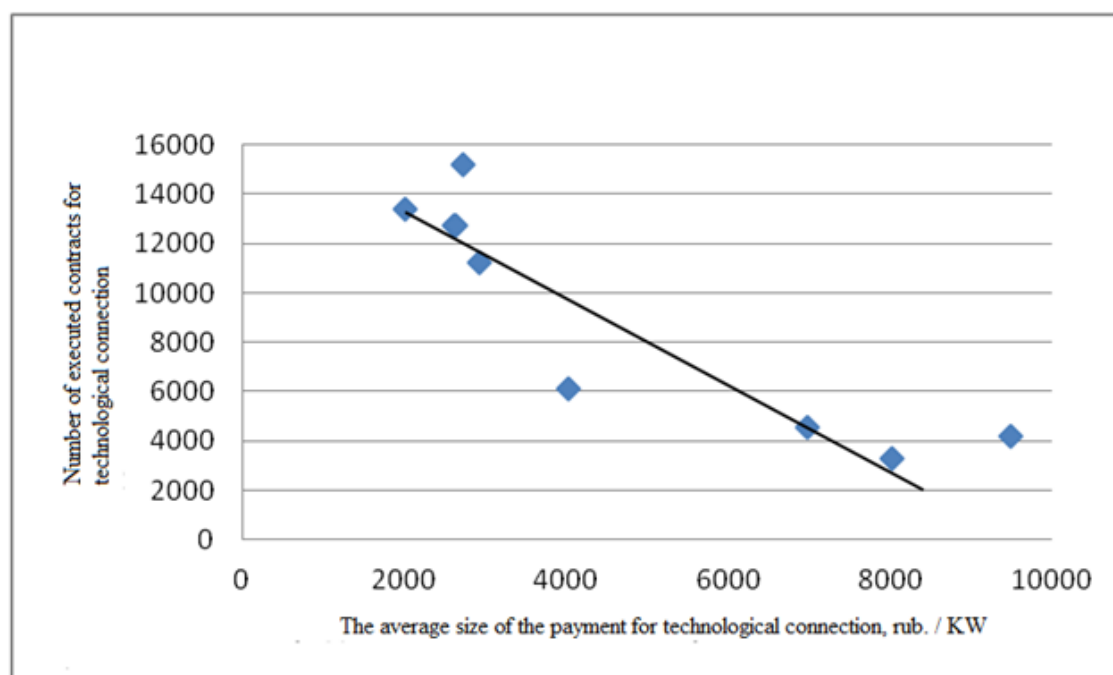


Figure 1. Relationship between the numbers of executed contracts on technological connection to electrical networks and the average amount of charge for a technological connection in PJSC ROSSETI

The regression equation for the numbers of executed contracts on technological connection to electric networks and the average size of charge for technological connection is as follows: The regression equation shows the inverse relationship between the number of executed contracts for technological connection to electric networks and the average amount of charge for technological connection. In this case, the dependence is very close, as evidenced by a high coefficient of determination (80, 49%). Thus, it is determined that a reduction in a charge for technological connection leads to an increase in the client base, i.e. makes technological connection more affordable, but there is an inverse relationship - an increase in the number of contracts (applicants) leads to lower costs, and consequently, charge for technological connection.

It should be noted that in the companies that are subjects of natural monopolies, to which electric grid companies belong, there is a “scale effect”, i.e. with an increase in the volume of products or services, the specific total costs decrease, what is confirmed by the figure above. This means that natural monopolies are interested in increasing the volume of customers and sales, what can lead not only to an increase in revenues, but also to lower costs, and consequently, to an increase in profits with fixed tariffs for their services. Thus, the electric grid companies have their own incentives to attract new customers and in this situation can go for the free technological connection of applicants, receiving compensation for shortfalls in income through the actual profit of the tariff for electricity transmission services. A similar situation is observed not only in conditions of natural monopolies, but also in conditions of limited competition. For example, let's study the satellite operators companies. Companies in this field of activity also bear the costs of providing subscribers with access to services:

- data transfer;
- reception of satellite television and radio broadcasting programs;
- telemetry transmission;
- Telephone service, etc.

In conditions of competition between operators, the latter try to provide satellite communications equipment for free or only for a fee that covers organizational costs. Investment expenses and entrepreneurial profits are covered by a variety of tariff

menus for providing the above services. This also creates a “scale effect” (for those companies that have a large share of fixed costs in total costs, the more customers, the lower the operating costs per unit of production). Consequently, an increase in the client base for satellite communications companies, electrical networks and other similar infrastructure organizations is advantageous, as the unit costs are reduced and there are even opportunities to lower prices while increasing business profits. However, it is impossible not to notice the significant problems associated with large gaps between the capacity specified in the application and the capacity for which the contract was concluded, as well as between the capacity of the contract and the actually used (see table). Power companies have repeatedly raised the issue of toughening the responsibility of regions and consumers for submitted applications for technological connection. [14] But, firstly, the “Soviet total deficit” have taught companies to form overstated applications (“ask for more, as they will give half”), secondly, the applicants still pay only the actual power consumption and do not carry any financial responsibility for a “Power reserve” formed even under the contract, and thirdly, by paying the amount of connected capacity under the contract, consumers have the right to use it as they see fit and can transfer it to another consumer, but only of their own accord. [15] It should be noted that although there is a positive trend in solving these problems, and the amount of actually connected power approaches the level fixed in the contracts (and in 2017 it even exceeded the power level under the contracts concluded), the final decision is usually associated with the adoption of a resolution of the Government of the Russian Federation on payment of margin capacities and introduction of contracts based on the “take or pay” principle specified in the Strategy for the Development of the Electric Grid Complex [2]. The “take or pay” agreements imply the obligations of the supplier to deliver the services (products), and the buyer to accept and pay for it, regardless of future use.

4. Discussion

The offer of B.I. Fayn on improving the efficiency of the contractual relationship system by introducing a capacity charge rate (subscription fee) covering all costs of grid companies in payments for electricity with separate categories of consumers, including with the population and consumers equivalent to them, seems unacceptable.[16] The introduction of such a rate for settlements with the population will only increase the cost of technological connection, which currently amounts to 550 rubles in Russia, i.e. a nominal fee, and

will not solve the problem of availability of electricity. For "other" consumers, the maximum power charge rates are provided for in the tariff menu for technological connection services. The proposals of [11] to improve the effectiveness of the contract system deserve attention: they propose an increase in the size of the penalty for non-compliance with the terms of technological connection introduced since the end of 2016. The authors propose to increase the value of the penalty to a cost comparable to the rental of a diesel generator. [17] This, in our opinion, may contribute to the growth of interest of a grid company in the early implementation of the contract, and to more substantial compensation for damages to consumers due to the delay in technological connection due to the fault of the grid organization.

However, it should be borne in mind that the terms for technological connection can be broken not only through the fault of the network organization, but also through the fault of the applicant.

Another problem is reflected in the negative dynamics of applications for technological connection and also concluded and executed contracts that has been noted since 2015, what indirectly indicates a low rate of development of the Russian economy. But, perhaps, this is a consequence of the development of power industry decentralization.

The development of decentralized, including non-traditional, energy sources of low power close to consumers is observed all over the world. Further development of the process will inevitably lead to a reduction in number of those who desire to perform technological connection to the distribution electric network, and therefore, in order to attract consumers, it is urgent to make the networks more accessible to them. [18, 19]

Obviously, the work in this direction is underway. A significant reduction in the time and cost of technological connection to electric networks during the analyzed period is undoubtedly due to reengineering of this type of activity, which also results in shortening the stages of work on technological connection to networks, changing the algorithm and technology to perform work. [15] Foreign experience proves that reserves are still there and reengineering should be carried out comprehensively across all business processes, companies and maximum power levels. For example, in Germany, the period to perform technological connection is 28 days, and in the Republic of Korea it takes 18 days. [20]. The transfer of part of the expenses of electric grid companies in Russia from the activity on performing technological connections to the electric power transmission services leads to significant shortfalls in income. In accordance

with the Principles of Pricing, shortfalls in income should be compensated to regulated entities in the next regulatory period. However, we must bear in mind that:

- Currently, the growth rate of tariffs for electricity transmission services is determined by the "inflation minus" rate;

- Due to the relatively high operational and investment costs associated with the deterioration of networks and the implementation of investment and innovative projects, including the digitization of electrical grid facilities, the possibilities to include shortfalls in income into the rates are limited;

- Since 2012, electricity transmission service tariffs had become long-term, therefore, shortfalls in income of electric grids can be included in electricity transmission service tariffs by installments only for a long-term period (not more than 5 years);

- With a high growth rate of the electricity transmission service tariff, shortfalls in income may not be compensated at all. The strategy for the development of the electric grid complex in Russia for the period up to 2030 has created a limit on the share of transmission services in the average daily rate for electricity supply to the end user in the amount of up to 40%. [2]

The experience of foreign countries shows that:

- There is no single approach in the world with regard to charges for technological connection services; [21]

- Approaches to the formation of charges for technological connection to the main and distribution networks, to consumers and suppliers may be similar, as well as significantly different;

- Charge value is determined on the basis of cost components directly or indirectly related to the connection of additional consumers to the network [22];

- Different models of charging for technological connection are formed depending on the cost accounting completeness.

For example, in Japan, in the USA states of California and New Jersey (for the population), and in Brazil, technological connections for consumers with capacity less than 50 kW is either not charged at all, or covers only organizational expenses [23, 24].

On the other hand, there are countries, for example, Germany, France, Norway, Great Britain, Kazakhstan, where consumers pay for not only organizational expenses, but also all expenses for the "last mile" construction or most of them. [25, 26]. However, the question arises who will be an owner of the assets built at the expense of payment for technological connection. Once the "last mile" facilities become the property of an electric grid company, it would be necessary to give consumers the opportunity, by reducing the tariff for electricity transmission services,

to recoup their costs for technological connection to the electrical network. Some compensation can be offered to manufacturers. It is obvious that electric grid companies are not interested in this and lobby for other solutions to this issue.

Meanwhile, the experience of many countries shows that the practice of calculating charges for technological connection to electrical networks is very diverse and may take into account mechanisms for compensation to applicants in part or in full. For example, in Spain and in some states of the USA, work on technological connection can be carried out entirely by electric grid companies or with the involvement of contractors who will be chosen by consumers, and which services they will pay for. In addition, even the agreement on technological connection can be terminated after a certain period of time and concluded with new consumers who partially pay the costs of previous consumers [27].

5. Conclusion

Considering the domestic and foreign practice on performing technological connection of applicants to electrical networks, the following conclusions and proposals on the formation of a supply chain strategy and charge for technological connection can be made:

1. The work done by the electric grid companies on the technological connection of applicants to electrical networks should be highly appreciated: as a result of this work, Russia's rating in terms of "Connection to the electrical networks" rose from 183 to 10 in the period of 2012-2017.
2. It is necessary to recommend to electric grid companies to continue work on reengineering of their type of activity "technological connection to electric networks", taking into account the expansion of consumer categories, the maximum power level and voltage.
3. The charge for technological connection of the population and small businesses should be completely abolished; that will create better conditions for the availability of power supply.
4. For medium-sized businesses, the payment for technological connection to electrical networks should include organizational costs and costs associated with the "last mile" facilities. But the tariff for electricity transmission services should be preferential for a payback period concerning costs invested in the "last mile" construction. If substantial amounts of work are required to expand the network, the network organization must determine the list of works that it must perform by itself, and for the remaining volume of works, the applicant must select a contractor who has previously passed qualification in a network

organization. This contracting organization on the terms of EPCM-contract (engineering - procurement - construction - management) must perform the necessary scope of work and transfer the constructed network assets to the operational management of the electric grid company. In this case, there will be no payments for technological connection to electric grids, new assets will belong to medium-sized businesses, and tariff for electricity transmission services will be set for the grid management company, taking into account the coverage of all expenses (including investment) of the grid organization.

5. For large businesses, there should be no charge for technological connection. But a big business should participate on a share basis in the development of the electric network and, accordingly, participate in the share capital of the grid company. The tariff for electricity transmission services, as well as in the case of medium-sized businesses, will be set for the grid management company

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